

Executive Summary

I. Project Objective

The Liberty Consulting Group (*Liberty*) investigated Commonwealth Edison Company's (*ComEd's*) transmission, distribution, and related management systems to describe and evaluate those systems as they existed during the summer of 1999, compare ComEd's systems to good utility practices, report areas where ComEd's systems fell short of those good utility practices, and specify the actions needed to move ComEd to the higher standard. This is the third of a series of reports on the results of Liberty's investigation. Liberty issued its first report in June 2000 and the second report in July 2000. Chapter One of the first report summarized Liberty's investigation methods and provided a list of terms and definitions that may be useful to the reader of the other reports in the series.

As a result of the outages that occurred in July and August of 1999, ComEd undertook many initiatives to improve its performance. The changes resulting from these initiatives were occurring during this investigation. It may be that ComEd is in the process of implementing some of the recommendations made in this report. In some cases, Liberty was aware of ComEd's current plans or actions, and mentioned them in this report. However, Liberty did not allow ComEd's current activities and plans to influence the content of this report. It was the intent of Liberty and the Illinois Commerce Commission Staff that this report will serve as the basis for a future investigation of ComEd's systems, after ComEd has had reasonable time to bring them up to the standards of good utility practice.

The Commission stated and Liberty adopted the following goals for the project:

1. evaluate ComEd's planning, procedures, and practices used to mitigate any deficient system performance;
2. evaluate ComEd's planning for and execution of emergency response and system restoration efforts;
3. evaluate ComEd's internal and external communications related to outages and service restoration;
4. evaluate ComEd's inspection, maintenance, replacement, and upgrading of equipment and overall transmission and distribution system;
5. evaluate ComEd's system performance compared to other major metropolitan service territories, detailing significant differences and similarities in system operation, planning, and design; and
6. evaluate ComEd's organizational and management structure and the adequacy of performance measures used to evaluate personnel and system reliability.

II. Scope

Liberty conducted this investigation of ComEd's transmission and distribution systems according to the Illinois Commerce Commission request for proposals and the subsequent contract between Liberty and the Commission. The Commission Staff had developed two lists of questions for Liberty to answer: Energy Division, Engineering Department Questions for ComEd Outage Investigation and Distribution Reliability Review and Energy Division, Engineering Department Questions for ComEd Outage Transmission Reliability Review. The Commission Staff asked that Liberty examine two previous investigation reports and determine if ComEd had implemented the recommendations they contained: Report on the Investigation of the Electric Transmission and Distribution Reliability of the Commonwealth Edison Company, by Resource Management International, dated March 1992 and Investigation of Service Interruptions in the Commonwealth Edison System During the July 12-16, 1995 Heat Wave, by Failure Analysis Associates, dated November 28, 1995. The Commission Staff also asked Liberty to review two October 27, 1998, ComEd management presentations to the ICC, Statement of John W. Rowe and Paul McCoy Presentation to ICC on October 27, 1998, and determine if ComEd has performed the actions detailed therein. Finally, the Commission Staff asked Liberty to review the report on the July-August 1999 outages, when completed by Vantage Consulting, and identify any leads, findings, or recommendations appropriate for inclusion in Liberty's investigation.

III. Summary of Findings

Liberty's first and second reports contained Chapters One through Fifteen and focused on ComEd's distribution system and certain aspects of management systems. Those chapters contained a common theme. ComEd possessed good standards, policies, procedures, and practices, and good people to carry them out, but often failed to meet its own standards or follow its own procedures because it failed to budget enough money for necessary capital improvements and maintenance. In many aspects, ComEd was in a reactive mode of operation, often waiting for parts of its distribution system to fail before taking any action and only attempting to improve the worst parts of its distribution system.

This report, which contains Chapters Sixteen through Twenty-Five, includes Liberty's evaluation of additional aspects of ComEd's management systems and begins reporting on ComEd's transmission system. Liberty found that ComEd's transmission system provided reliable service and did not suffer some of the same problems as the distribution system such as having parts of its system overloaded. However, there were similarities to Liberty's earlier findings as well. For example, ComEd allowed the condition of the transmission system to deteriorate. If not found and corrected, these conditions could have had a significant effect on the reliability of electric delivery service.

This section is organized by report chapter and consists of short pieces of text taken from the body of this report to give the reader a sense of the content of each chapter. This is not a collection of Liberty's conclusions, which can be found at the end of each chapter, although the content is similar.

Chapter Sixteen – T&D Work Management and Manpower Planning Practices: Liberty found that ComEd's work management and manpower planning practices were not consistent with good utility practices. Work management systems did not provide the advantages available to those with more sophisticated systems. Manpower planning systems simply relied on historical information and did not use tools that would have permitted optimizing staffing levels, work performance, and service performance.

Chapter Seventeen – Customer Service: Liberty found that in virtually all areas ComEd's customer service performance declined and was not consistent with good utility practices during most of the 1990s. There were several measures of the performance of ComEd's customer service, for example:

- ComEd's delayed bills per 1,000 accounts increased steadily from 1992 through 1997, more than tripling from 6.4 to 19.5.
- ComEd's meter reading effectiveness declined from a high of 98.9 percent in 1992 to a low of 95.3 percent in 1999.
- Average speed of answer is among the most widely used performance measures for customer service telephone representatives. ComEd's average speed of answer increased substantially from 1992 to 1998.

Chapter Eighteen – Communications: Liberty found that ComEd's outage-related communications were ineffective, primarily due to insufficient policies and procedures and a confusing organizational approach. Although the company's communications functions were adequately funded, staffed, and equipped, information provided to constituents was often inaccurate and untimely, and caused significant dissatisfaction among customers.

Chapter Nineteen – Transmission System Planning: Liberty found that ComEd's transmission system performed well. However, ComEd's transmission system planning design criteria were incomplete and its transmission system planning was based on inadequate load forecasts. In addition, ComEd failed to fully meet its own design criteria and did not go beyond its minimum criteria in some specific areas of its service territory that posed unique reliability risks.

Chapter Twenty – Transmission System Design: Liberty found that ComEd had appropriate transmission design standards that were consistent with good utility practices. In addition,

ComEd had the appropriate technical resources to conduct its transmission system design and employed the appropriately skilled professionals to do so.

Chapter Twenty-One – Transmission System Construction: Liberty found that ComEd's decisions regarding whether to construct with contractors or its own work forces were appropriate and that ComEd's one-year acceleration of its Lockport-Lombard line was commendable. ComEd's experimental turnkey procurement of its Elmhurst-Oakbrook line has been disappointing.

Chapter Twenty-Two – Transmission System Protection: Liberty found that ComEd performed well in the areas of transmission system protection planning, design, and installation. However, ComEd's maintenance and testing of transmission system protection relays were marginal. The maintenance backlog and testing intervals could have contributed to the number of transmission protection system mis-operations.

- ComEd reduced significantly the number of relay packages maintained each year from a high of 4,500 in 1990 to approximately 1,200 in 1998. The number maintained in 1998 was less than 10 percent of all relay packages. As of July 1, 1999, the relay testing backlog was 2,433. ComEd indicated that other work interfered with relay testing in 1997 and 1998.
- In 1998, ComEd increased the testing interval by 50 percent in the name of reliability-centered-maintenance.

Chapter Twenty-Three – Transmission System Maintenance and Inspection: Liberty found that ComEd's transmission system maintenance had been somewhat neglected, but overhead transmission outages related to poor maintenance had not been occurring at a high rate.

- During the period of 1991 to 1998, ComEd's overhead transmission system experienced approximately 930 momentary interruptions and 135 sustained outages. During those eight years, about 200 interruption were caused by equipment failures, of which only 15 occurred during 1998. The resulting overhead availability index was 99 percent.
- The performance of the underground transmission system, however, had not been adequate. In ComEd's history, there has been 82 underground transmission cable failures, including about 75 maintenance-related failures. About 13 cable joint failures had occurred during the 18-month period preceding August 1999. Eight of these were joint failures in new XLPE transmission cables, installed since 1996.

- The failure of the Bakelite sleeved 69kV cable joints at the Jefferson substation in Chicago on August 12, 1999 contributed to a lengthy interruption of service to a large number of ComEd's customers.

Chapter Twenty-Four – Transmission System Conditions: Liberty found that ComEd's inspection and maintenance of the transmission system were inadequate after about 1992.

- In 1992, ComEd reduced transmission line maintenance, and reduced inspections to a point that helicopter inspections were not made at all after 1997. After the summer 1999 reliability problems surfaced, ComEd did a thorough inspection of the overhead system and found nearly 24,000 separate problems.
- As of the summer of 1999, ComEd had many Bakelite joints on its transmission system. Some of those joints failed during the summer 1999 outages. These joints were a weak link in the underground transmission cables due to their propensity to fail. ComEd developed a plan to replace these joints only after the severe reliability problems that occurred in the summer of 1999.

Chapter Twenty-Five – Transmission System Operations - Control and Dispatch: Liberty found that ComEd had a state-of-the-art SCADA system for its transmission system, but that its transmission system operators were not provided with state-of-the-art training. ComEd's system operators had been provided with appropriate pre-planned operational procedures. ComEd had effective management oversight, system operators conducted economic dispatch effectively.

IV. Summary of Recommendations

At the end of chapters of this report are recommendations, where appropriate, relating to the subject matter of the chapter. This section is a collection of those recommendations. Each recommendation is identified with a number that shows both the chapter from which it is taken and the recommendation number within the chapter.

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| Sixteen-1 | ComEd should develop and implement a fully integrated work management program for all of T&D. |
| Sixteen-2 | ComEd should develop and implement manpower planning models that take advantage of data collected by the T&D Operations organization's work management systems. |
| Sixteen-3 | ComEd should develop and use quality-of-service indicators that measure the effect of staffing levels. |

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| Seventeen-1 | ComEd should conduct an in-depth assessment of customer service performance and report the findings to the ICC. |
| Eighteen-1 | Revise and update corporate policies and develop comprehensive procedures related to outage communications. |
| Eighteen -2 | ComEd should make organizational changes needed to maximize the effectiveness of outage related communications. |
| Eighteen -3 | ComEd should develop specific, measurable goals and objectives for improving the accuracy and timeliness of outage related information provided to its constituents. |
| Nineteen-1 | ComEd should amend its transmission system reliability criteria to prevent common mode failures and coupled contingency risks. |
| Nineteen-2 | ComEd should modify its load forecasting methods. |
| Nineteen-3 | ComEd should make it clear that it has exceptions to its single contingency criterion. |
| Nineteen-4 | ComEd should develop an integrated cost versus reliability system. |
| Twenty-Two-1 | ComEd should revise the testing interval for transmission system protection relay packages and develop a program to catch up on the backlog of relay testing that developed. |
| Twenty-Two-2 | ComEd should continue its present investigation into the poor performance of reclosing on transmission lines and replace all obsolete reclosing relays that contribute to the poor performance. |
| Twenty-Two-3 | ComEd should adopt a goal of at least 85 percent for the successful reclosing operations on its transmission system. |
| Twenty-Three-1 | ComEd should review overhead and underground transmission RCM analyses for costs and benefits and verify that PM program maintenance guides are consistent with RCM analyses. |
| Twenty-Three -2 | ComEd should address and correct maintenance items identified by the inspection programs according to its maintenance program schedules. |

- Twenty-Three-3 ComEd should conduct formal overhead and underground transmission inspections according to its most recent maintenance programs.
- Twenty-Three-4 ComEd should start the practice of periodically testing oil in transmission oil-filled cables. ComEd should also initiate a program on cables that have experienced overloading or high failure rates.
- Twenty-Three-5 ComEd should complete a review with cost-benefit evaluations of using tests listed below for transmission cables.
- Twenty-Three-6 ComEd should perform the special overhead transmission maintenance programs pending in August 1999, including placing defective hairpin spacers, insulators, switch repairs and replacement, and painting of structures.
- Twenty-Three-7 ComEd should give transmission system maintenance equal priority to distribution system and substation maintenance. The transmission system maintenance programs should be funded to accomplish the assigned tasks according to ComEd's maintenance programs and RCM analyses.
- Twenty-Three-8 To provide focus and ownership, transmission system maintenance should be under the supervision of one system overhead transmission maintenance manager and one system underground transmission maintenance manager. These managers should be provided with sufficient engineering and regional or contract workforce to accomplish the maintenance tasks per ComEd's programs. These managers should be able to modify maintenance programs based on the results of ongoing programs, with the assistance of the maintenance analysts.
- Twenty-Three-9 ComEd should completely integrate overhead and underground maintenance programs into Maximo or other integrated maintenance tracking system. The maintenance tracking system should be set up to audit different types of defects found in inspections in order to identify common problems.
- Twenty-Four-1 ComEd should continue the overhead transmission system inspection plan that was initiated after the summer 1999 outages.
- Twenty-Four-2 ComEd should replace all of the Bakelite joints on its underground transmission cables.